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DTU Nanotech
Department of Micro- and Nanotechnology

Injection moulding antireflective nanostructures

Alexander Bruun Christiansen[1], Jeppe Clausen[2],

N. Asger Mortensen[2], and Anders Kristensen[1]

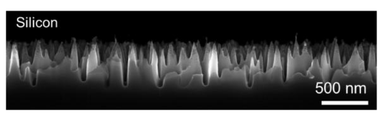
[1] DTU Nanotech Oersteds Plads Building 345 East DK 2800 Kongens Lyngby, [2] DTU Fotonik, Technical University of Denmark

Introduction

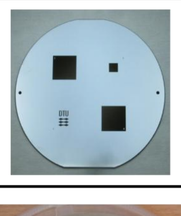
Can expensive multilayer antireflective coatings for e.g. glasses and camera objectives be replaced by cheap nanostructured surfaces?
Here we take one step in that direction, by injection moulding antireflective nanostructures on large areas, based on inexpensive, black silicon masters.

Fabrication

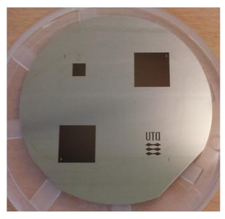
a) Black silicon is etched using reactive ion etching.



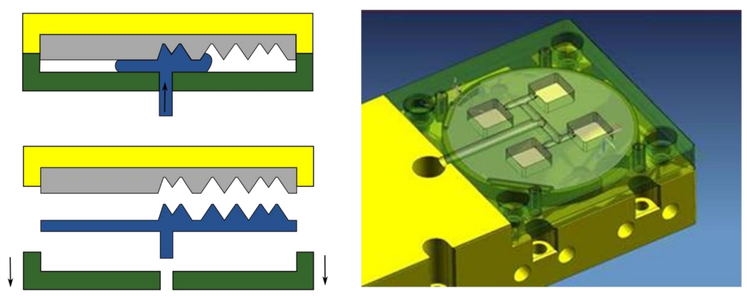
b) The black silicon is patterned using UV lithography.



c) A nickel shim is fabricated from the black silicon master, using electroplating. The Ni shim is anti-stiction coated.



d) The nicklel shim is inserted in an injection moulding tool. The parts are being moulded with a cycle time of 30 seconds.

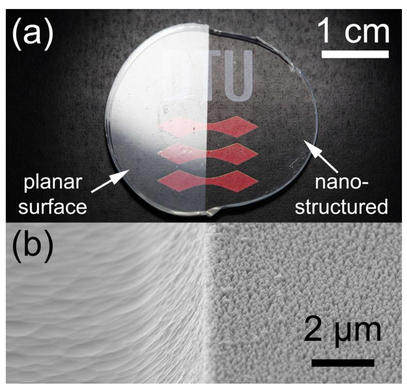


e) The final part in a black polymer. The antireflective nanostructures are seen as dark areas.

Silicon master | Nickel shim | Injection molding tool | Polymer

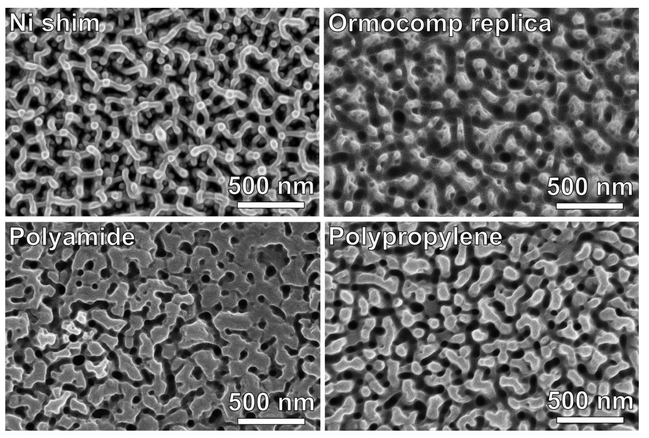
Background

In previous work [1], black silicon has been used for fabricating antireflective surfaces on transparent substrates. The nanostructures were optimized for maximum transmission of light. Control of the lateral size of the structures was crucial in order to avoid scattering from the random black silicon surface. A characteristic period below 160 nm was nescessary in order to avoid scattering.

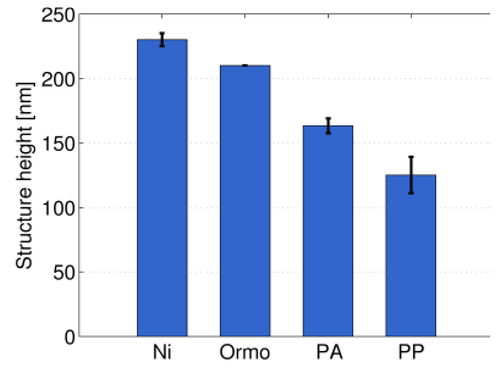


Characterization

The injection moulded samples were characterized with scanning electron microscope (SEM) and atomic force microscope (AFM). The structures were compared to the Nickel shim mould, and an Ormocomp replica, casted directly from the Ni shim (Ormocomp is a UV-curable resin from micro resist technology GmbH).



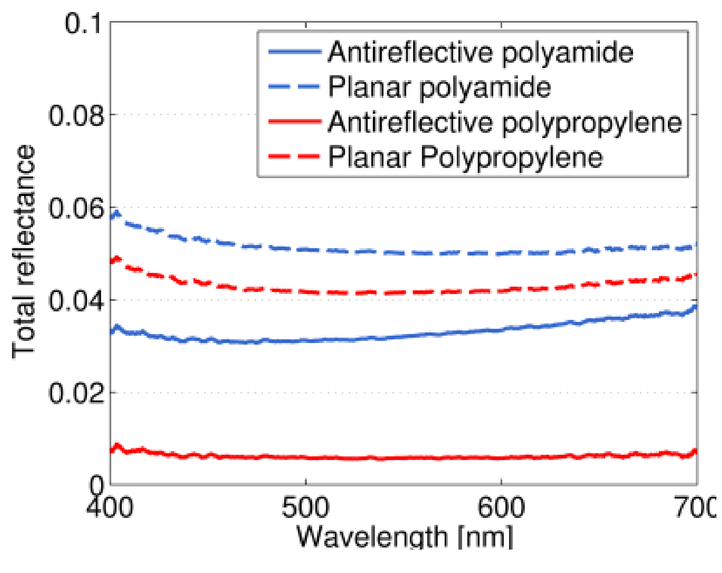
The SEM images offer a qualitative comparison of the different samples. The heights of the nanostructures were compared, from the AFM measurements. The filling of the injection moulded structures is 70% and 60% for polyamide and polypropylene respectively.



Optical measurements

The total reflectance of the black injection moulded samples was measured using an integrating sphere.

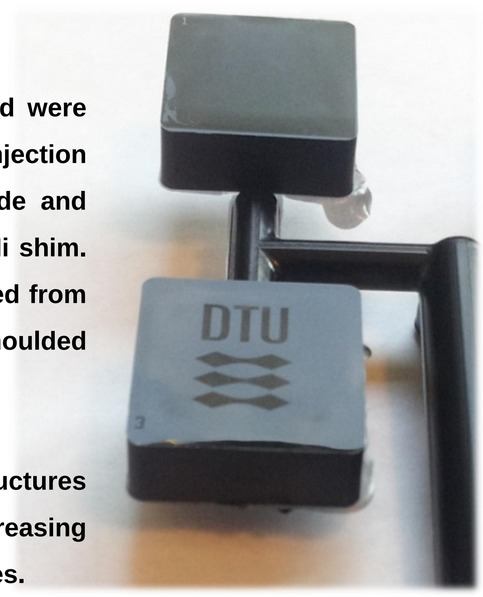
The total reflectance of the polypropylene was reduced from 4% to below 1%, due to the nanostructured surface.



Conclusion and outlook

Nanostructures of 160 nm height and 200 nm period were injection moulded from a Ni shim. The filling of the injection moulded structures was 70% and 60% for polyamide and polypropylene respectively, when comparing to the Ni shim. The total reflectance of the polypropylene was reduced from 4% for a planar sample, to 1% for the injection moulded nanostructured sample .

In future work we will be injection moulding nanostructures in transparent polycarbonate, with the scope of increasing transmittance through the injection moulded substrates.



[1] Link to ref.

Acknowledgments

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[1] A. B. Christiansen, J. Clausen, N. A. Mortensen, A. Kristensen, Appl. Phys. Lett. **101**, 131902 (2012)

DTU Nanotech
Department of Micro- and Nanotechnology

DTU Fotonik
Department of Photonics Engineering

Presenting author
Alexander Bruun Christiansen
Ph.D. Student
abrch@nanotech.dtu.dk

Authors affiliation
NSE Optofluidics
Anders Kristensen
www.nanotech.dtu.dk/ak